PB90-246190

Technical and Regulatory Status of Solidification/Stabilization in the United States

(U.S.) Environmental Protection Agency, Cincinnati, OH

1989

U.S. Department of Commerce
National Technical Information Service
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1. REPORT NO. EPA/600/D-90/057	2.	3. PB90-246190
4. TITLE AND SUBTITLE Technical and Regulatory Status of Solidification/-Stabilization in the United States		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Barth, E. Wiles, C.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Risk Reduction Engineering Laboratory - Cincinnati, OH Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Risk Reduction Engineering Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268		13. TYPE OF REPORT AND PERIOD COVERED Complete 14. SPONSORING AGENCY CODE EPA/600/14

15. SUPPLEMENTARY NOTES
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For presentation at KEPA, Seoul, Korea ~ May 1989.

16. ABSTRACT

Solidification/Stabilization is currently being used for the treatment of industrial sludges, contaminated soil, and municipal combustion ashes. In general, solidification/stabilization is effective in reducing the leaching of heavy metals from these waste types. More research is needed for organic waste streams. Current testing methods only indicate long-term physical and chemical durability.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

18. DISTRIBUTION STATEMENT Release to Public.	19. SECURITY CLASS *(This Report)* UNCLASSIFIED 20. SECURITY CLASS *(This page)* UNCLASSIFIED	21. NO. OF PAGES 22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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EPA/600/D-90/057

PB90-246190

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Conference No. 2
Solid and Hazardous Waste Technology

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STATUS OF LAND TREATMENT AS A HAZARDOUS WASTE MANAGEMENT ALTERNATIVE IN THE UNITED STATES

for presentation at

KEPA, Seoul, Korea
May 1989

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1. INTRODUCTION

Land treatment technology has been used for several years as a waste management alternative for treatment of industrial organic sludges and residues. Two of the major users have been the petroleum refining and food processing industries. Other users of note include the wood preserving and pulp and paper industries. In 1989 approximately 100 operating land treatment units were in existence for each of the two major users and approximately 50 operating units combined for the other two industries of note. In addition, the technology currently is being used for the remediation of selected organically-contaminated soils at uncontrolled hazardous waste sites.

Successful utilization of land treatment technology relies on the capacity of natural soil biological, chemical and physical processes and interactions to detoxify organic hazardous constituents within a defined treatment zone before such constituents can be transported from that zone. The primary detoxification mechanism is microbial degradation.

1.1 Land Treatment Technology

1.1.1. Definitions. Land treatment should be distinguished from other biological processes such as in situ treatment or bioreactor treatment. Land treatment involves controlled application loadings on a contained management area, usually near the source of contamination.

In situ treatment systems are designed to meet the goals of onsite biodegradation without physically removing the contaminated soils from the contiguous environment.

Bioreactor treatments are generally based on design fundamentals taken from chemical and environmental engineering reactors.

Bioreactor technology is usually implemented in a tank reactor.

1.1.2. Land Treatment Reaction Mechanisms. Degradation of waste and waste constituents describes the loss of parent compounds through chemical and biological reactions within the soil/waste matrix. Complete degradation is the term used to describe the process whereby waste constituents are mineralized to inorganic end products, generally including carbon dioxide, water, and inorganic species, such as nitrogen, phosphorus, and sulfur. The rate of degradation may be established by measuring the loss of the parent compound with time. The biodegradation potential of hazardous constituents in waste(s) to be applied at the proposed land treatment facility is critical as biodegradation usually represents the primary removal mechanism for organic constituents in waste(s).

The chemical and/or biological conversion of hazardous constituents to less toxic intermediates within the land treatment unit should be evaluated in a determination of hazardous waste land treatability. Transformation may be addressed along with degradation based on parent and intermediate compound characterization procedures. Chemical and bioassay analyses are recommended to ensure that transformation/detoxification processes are active in the soil/waste mixture.

Immobilization refers to the affinity of a chemical for particulate surfaces in the soil treatment zone. Chemicals that adsorb tightly to soil may be less subject to environmental transport in the solution (leachate) phase and/or in the gaseous (volatile) phase. Leaching refers to the movement of materials through the treatment zone to deeper soils and/or to groundwater. An evaluation study for a properly operating land treatment site should show the absence of hazardous constituent migration. Volatilization refers to the process by which applied materials are lost to the atmosphere. Leaching and volatilization may be evaluated through use of a land treatment mathematical model.

1.1.3. Design Principles. A land treatment demonstration (LTD)

addresses the requirements in the regulations that the owner or operator of a land treatment unit must demonstrate, prior to application of the waste, that hazardous constituents in the waste can be completely degraded, transformed, or immobilized in the treatment zone. An LTD is also required to establish the protectiveness of human health and the environment for the design and management strategy used for a waste at a site.

Successful performance of the LTD is required in order to obtain a final permit under 40 CRF Parts 264 and 270 for a treatment unit. Permit options for land treatment differ from those of other land disposal technologies. The LTD, much like the trial burn for incinerators, may require a permit to allow for trial performance. A trial performance for an LTD may be conducted under a short-term demonstration permit or a two-phase permit. It is also possible to apply directly for a full scale permit. The applicable permitting scenario depends in part on 1) whether the unit is new or existing, 2) the conditions of the site, and 3) past, present, and planned operations.

The technical approach to accomplishing the goal of demonstrating land treatment is to provide a methodology for evaluating site, soil, and waste characteristics and for assessing waste treatment processes within the soil treatment zone. The soil treatment zone is defined in Section 264.271 as no more than 5 feet (1.5 m) depth from the initial soil surface, and more than 3 feet (1 m) above the season high water table. The methodology is used to determine the potential for a soil to assimilate a candidate hazardous waste (soil site assimilative capacity) so that there is no statistically significant release to the environment from the treatment zone.

The U.S. EPA has published a Land Treatment Guidance manual for design and review of land treatment systems.

The following informational requirements necessary in a bench scale evaluation of a land treatment system are:

- identification of factors influencing and limiting biodegradation;
- biodegradation rate;
- extent of degradation and formation of intermediate products.

The performance of the system in the field should also include ground water monitoring. Appropriate closure methods are necessary when operation ceases.

1.1.4. Management Techniques. Management techniques are necessary for operational purposes as well as treatment efficiency enhancement. Many of the techniques evaluated included:

- addition of nutrients;
- tilling to increase oxygen transfer;
- irrigation;
- addition of carbon substrates;
- emulsifying agents;
- pH.

2. THE U.S. EPA PROGRAM IN LAND TREATMENT

The U.S. Environmental Protection Agency (U.S. EPA) has supported extensive land treatment research regarding the fate of industrial organic compounds which have been classified as hazardous under 40 CFR 261 (Appendix VIII constituents). Because of this classification, many industrial wastes (e.g., petroleum and wood preserving sludges) are now subject to regulations specified under the Resource Conservation and Recovery Act (RCRA) and land treatment facilities which receive these wastes must now apply for a RCRA permit for continued operation.

Laboratory results have suggested that all Appendix VIII organic constituents found in petroleum and wood preserving wastes can be degraded in soil under proper management conditions before they can migrate below the treatment zone. However, since much of this data were determined under very controlled conditions (often using single compound additions to soil), it may not be prudent to extrapolate laboratory results for predicting the fate and transport of hazardous constituents contained in complex wastes. To estimate compound interactions in the subsurface, the U.S. EPA is sponsoring cooperative research aimed at addressing the

following concerns:
(a) interactions of complex wastes in the soil matrix; (b) transport of organics through the treatment zone; and (c) partitioning of chemicals into the vapor phase.

For the safe operation of land treatment systems, decision makers must have a thorough understanding of the various processes which affect the rate and extent of chemical removal within the treatment zone. The fate and transport of hazardous organic constituents in land application operations have been estimated through soil interactive chemical simulation models such as the Regulatory and Investigative Treatment Zone Model (RITZ) and the Vadose Zone Interactive Processes Model (VIP). These models consider transport of pollutants with the soil solution, partitioning into the oil phase, volatilization and loss to the atmosphere, and degradation.

Presently, the RITZ model is being utilized to determine the land treatment potential of a given waste. Data from the RITZ and similar models will be evaluated in constructing the lists of hazardous wastes to be banned/permitted in land treatment operations. Current U.S. EPA research is focused on validating model parameters to enhance its general predictive capability.

Field scale evaluation of hazardous waste land treatment site performance continues to be a top priority of the U.S. EPA. The Robert S. Kerr Laboratory (U.S. EPA) is presently evaluating a field scale hazardous waste land treatment (HWLT) site receiving wastes from chemical wood preserving production operations. In addition to monitoring the fate and transport of the hazardous constituents in the subsurface, volatilization of organics from the site is being quantified. Similarly, Environment Canada and the Robert S. Kerr Laboratory are working in conjunction to estimate the fate and transport of hazardous constituents from petroleum refinery sludges being applied at the Texaco Nanticoke Refinery Land Treatment Site in Ontario, Canada. Monitoring of air emissions for hazardous constituents from this operation is also included in the field scale

experimental program.

In addition to the management of hazardous land treatment systems, the U.S. EPA is supporting laboratory studies aimed at developing proper guidelines for closure of hazardous waste land treatment sites. This effort is evaluating the mobility of hazardous constituents from soils which have been subjected to long term application of hazardous wastes from the oil refining, wood preserving, and coal gasification industries. Data from leaching and biodegradation studies will be used to determine if these soils should be considered hazardous and thus subject to RCRA hazardous waste legislation.

3. REGULATORY STATUS

Current Federal regulations include a no migration demonstration for land treatment systems. The potential release of volatile organics from land treatment units may be regulated in the future. Volatile organics may need to be removed from waste before it is applied to a land treatment system.

SUMMARY

Land treatment has been used in the United States for industrial sludges. Properly designed and operated facilities should be effective for several waste matrices. The release of volatile organic compounds needs to be addressed during system design.